

TABLE 2.—Free-air resultant winds (meters per second) based on pilot-balloon observations made near 5 a. m. (E. S. T.) during February 1938—Continued

[Wind from N=360°, E=90°, etc.]

Altitude (meters) m. s. l.	Newark, N. J. (14 m)		Oakland, Calif. (8 m)		Oklahoma City, Okla. (402 m)		Omaha, Nebr. (306 m)		Pearl Har- bor, Terri- tory of Ha- waii ¹ (88 m)		Pensacola, Fla. ¹ (24 m)		St. Louis, Mo. (170 m)		Salt Lake City, Utah (1,294 m)		San Diego, Calif. (15 m)		Sault Ste. Marie, Mich. (198 m)		Seattle, Wash. (14 m)		Spokane, Wash. (603 m)		Washing- ton, D. C. (10 m)	
	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity
Surface.....	327	2.5	141	2.7	262	0.3	350	1.8	10	1.0	27	2.9	237	1.6	151	4.0	75	0.7	76	1.7	133	1.0	104	1.1	305	1.6
500.....	308	6.0	202	2.8	200	2.4	333	1.8	158	1.1	63	2.4	237	4.4	225	0.4	93	2.1	154	3.5	154	3.5	289	5.4	289	5.4
1,000.....	306	8.8	229	4.8	232	8.4	287	5.1	199	1.3	298	2.6	259	7.6	251	0.7	317	3.1	180	5.2	134	2.3	300	7.3	300	7.3
1,500.....	302	10.9	243	4.9	250	7.7	291	6.2	219	2.2	319	4.1	279	9.7	197	1.3	312	6.1	184	7.0	204	3.4	292	10.2	292	10.2
2,000.....	311	12.9	252	4.9	265	8.9	295	7.4	233	3.3	303	5.1	272	10.1	181	5.2	228	3.2	321	7.5	174	4.9	219	4.1	291	10.9
2,500.....	299	10.2	256	4.3	265	9.3	290	9.1	266	3.3	296	5.2	300	11.2	199	4.8	253	4.1	318	8.6	165	5.4	231	2.6	289	12.5
3,000.....			307	5.9	267	8.2	281	9.8	276	5.6	304	3.0	285	11.5	215	5.5	256	7.1	320	12.1	154	4.7	219	2.6	292	13.2
4,000.....			324	12.9	277	10.7	255	8.6	267	4.0	302	5.3			224	6.4	285	10.9					346	2.0		
5,000.....																	286	10.3								

¹ Navy stations.

TABLE 3.—Maximum free-air wind velocities (meters per second), for different sections of the United States based on pilot balloon observations during February 1938

Section	Surface to 2,500 meters (m. s. l.)					Between 2,500 and 5,000 meters (m. s. l.)					Above 5,000 meters (m. s. l.)				
	Maximum ve- locity	Direction	Altitude (m). m. s. l.	Date	Station	Maximum ve- locity	Direction	Altitude (m). m. s. l.	Date	Station	Maximum ve- locity	Direction	Altitude (m). m. s. l.	Date	Station
Northeast ¹	42.1	NNW	2,500	28	Kylertown	52.1	NNW	2,950	28	Kylertown	33.2	NW	5,850	7	Columbus.
East Central ²	40.8	NW	1,900	28	Washington	42.8	NW	3,090	28	Greensboro	36.4	WNW	8,130	7	Knoxville.
Southeast ³	36.0	WNW	1,560	27	Charleston	35.6	WNW	4,530	28	Charleston	37.6	NW	10,000	1	Key West.
North Central ⁴	40.2	NNW	2,330	26	Minneapolis	42.8	NW	3,610	26	Fargo	38.0	WNW	5,590	9	Fargo.
Central ⁵	42.2	WSW	1,890	6	Moline	39.0	NW	2,930	27	Evansville	36.8	WSW	5,560	13	Wichita.
South Central ⁶	33.2	SSW	1,390	1	Oklahoma City	37.0	WSW	3,370	5	Oklahoma City	36.4	WNW	6,970	26	Amarillo.
Northwest ⁷	46.2	SSW	2,300	5	Medford	40.2	WSW	5,000	7	Boise	46.0	NW	7,130	15	Portland.
West Central ⁸	37.0	SE	810	9	Sacramento	38.0	SSW	2,800	10	Sacramento	61.6	N	8,600	17	Modena.
Southwest ⁹	31.5	SW	1,180	6	Havre	39.0	WSW	5,000	4	Albuquerque	59.0	NNW	10,640	17	Las Vegas.

¹ Maine, Vermont, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, and northern Ohio.² Delaware, Maryland, Virginia, West Virginia, southern Ohio, Kentucky, eastern Tennessee, and North Carolina.³ South Carolina, Georgia, Florida, and Alabama.⁴ Michigan, Wisconsin, Minnesota, North Dakota, and South Dakota.⁵ Indiana, Illinois, Iowa, Nebraska, Kansas, and Missouri.⁶ Mississippi, Arkansas, Louisiana, Oklahoma, Texas (except El Paso), and western Tennessee.⁷ Montana, Idaho, Washington, and Oregon.⁸ Wyoming, Colorado, Utah, northern Nevada, and northern California.⁹ Southern California, southern Nevada, Arizona, New Mexico, and extreme west Texas.

RIVERS AND FLOODS

[River and Flood Division, MERRILL BERNARD in Charge]

By BENNETT SWENSON

Precipitation during February was heavy over most of a wide belt extending from Texas and New Mexico north-eastward over the Lake region, and also in nearly all of the Pacific slope area. The relatively heaviest amounts occurred in California and the lower Great Plains where the rainfall was from 200 to 400 percent or more of the normal. On the other hand, in the South Atlantic slope and East Gulf of Mexico drainage area, it was one of the driest months of February of record.

The principal floods during February occurred in the rivers in Michigan, southern Wisconsin, and Illinois, the Meramec River in Missouri, the Wabash-White Rivers in Indiana, the White Basin in Missouri and Arkansas, the Arkansas and Red Basins, the St. Francis River in Missouri and Arkansas, the Trinity River in Texas, and in the San Joaquin and Sacramento Rivers in California.

St. Lawrence drainage.—Heavy rains in Michigan on February 5 and again on the 12th–13th caused two sharp rises in the Grand and Saginaw River systems and other small streams in southern Michigan. The snow cover was not excessive and did not have an appreciable effect on the flood, but the mild temperature and rain caused the

solid ice in the rivers to break up and resulted in ice jams that caused increased overflow.

The storm of February 12–13 broke all records for maximum short period rainfall, as well as for the 24-hour period for February at several points. The greatest amount occurred at East Lansing, Mich., where 4.33 inches occurred within 24 hours. This is the greatest of record at that point for the month of February or any winter month, and for any month in the past 33 years.

The intensity of the rainfall and presence of ice in the streams produced sudden rises that gave little time for warnings except in the lower portions of the streams. Damages have been estimated as follows: Grand River, \$95,200; Saginaw River, \$22,800; other rivers in south-eastern Michigan, \$119,350.

Atlantic slope drainage.—A severe local flood occurred in the Mohawk River at Amsterdam, N. Y., on February 7–8. The river rose 10.3 feet in 24 hours on February 6–7, due to moderate rains and high temperatures which caused moderately heavy run-off in the tributaries of the Mohawk River. In the meantime, the ice that had moved out of the Schoharie River on January 25 and had moved slowly

down the Mohawk, had jammed below the city of Amsterdam and the backing up of the water above the ice jam resulted in one of the worst floods ever experienced in that city. The estimated damage reached approximately \$100,000.

Colder weather on the 8th ameliorated conditions considerably, and although flood stage was exceeded at Schenectady, N. Y., by 1.4 feet, no damage resulted at that point.

East Gulf of Mexico drainage.—Heavy rains on the 18th–19th resulted in sharp rises in the Pearl and Pascagoula Rivers. However, fairly low stages prevailed before the rains occurred and no damage of consequence resulted.

Upper Mississippi Basin.—The following report on the floods in the Rock River Valley during January and February is made by the official in charge at Davenport, Iowa:

A flood of major proportions occurred on the Rock River during January and February. Overflows occurred on the minor tributaries, the Galena in Illinois, and Wapsipinicon in Iowa during this time.

Precipitation over northern Illinois on January 23 and 24, principally over the Rock River Valley, averaged 2.25 inches, with individual amounts of almost 3 inches. This precipitation falling on frozen ground and augmented by frozen ice and snow caused destructive floods on the Rock River and its tributaries. Ice gorges were formed which added to the destruction. These conditions began in the latter part of January and continued until February 25 in the lower part of the valley. The only gage maintained by the Weather Bureau on the Rock River is at Moline Bridge, Ill., and at that point the river exceeded flood stage on January 25 and continued above flood stage until February 26, with a secondary rise occurring on February 8, 9, and 10.

In the first rise a stage of 13.8 feet was reached at Moline Bridge on January 30. Additional rains and thawing began on February 6 and 7 and resulted in a second crest of 13.6 feet on February 10.

Two lives were lost during the flood and the property damage is estimated at about \$565,000.

The Illinois was at or slightly above flood stage at some points, beginning in January and continuing into March in the lower portion. So far the flood has been of little consequence.

The Meramec River was in flood from February 18 to 22. The river rose to 18.7 feet at Sullivan, Mo., on February 19, or 7.7 feet above flood stage, and to 24.0 feet at Valley Park, Mo., on February 21, or 10 feet above flood stage. However, no material damage was reported, owing to the earliness of the season.

Ohio Basin.—Some flooding occurred in portions of the Wabash-White Basin, beginning on February 19, and continuing into March in some parts of the West Fork and White Rivers. Practically no crops had been seeded and consequently little damage resulted.

Lower Mississippi Basin.—Excessively heavy rains over Arkansas, eastern Oklahoma, and northeastern Texas from about February 14 to 19, resulted in general floods in the White, Arkansas, Red, and St. Francis Basins, in most cases, exceeding the stages reached in the floods late in January and early in February. Total rainfall from the 14th to the 19th of February was 8.84 inches at Fort Smith, Ark., and 10.51 inches at Webbers Falls, Okla.

The White River reached a crest stage of 42.0 feet at Calico Rock, Ark., on February 18–19, or 24 feet above flood stage, and 31.5 feet at Georgetown, Ark., on February 23, 10.5 feet above flood stage, and exceeding the highest gage reading of record at that place, 31.3 feet on March 18, 1935. The total losses in the basin are estimated at slightly more than \$130,000.

The Arkansas River exceeded flood stage in the lower portion from about Webbers Falls, Okla., to the mouth, from February 16 to 25. Of the tributaries of the Arkansas River, the small streams in eastern Oklahoma and extreme western Arkansas were probably the most seriously affected. The Poteau and Petit Jean Rivers reached reported stages of about 10 to 15 feet above flood stage. Although no river gaging stations on the North or South Canadian Rivers reported flood stages, considerable damage occurred at some points. Total losses in the Arkansas Basin are estimated at about \$350,000.

The St. Francis River was in flood most of the month, and continued at the end of the month at some points. Two levee breaks occurred near Bertig, Ark., on the Arkansas side, on February 26, but the property loss is believed to have been slight.

The floods in the Red and Ouachita Rivers, which began late in January, had barely subsided when the heavy rains of February 14 to 19 caused a second flood which exceeded the first at most points. Losses resulting from high water were considerable, and levee breaks caused flooding of large areas. Estimated losses in the second flood in the Red River above Shreveport, La., are approximately \$550,000. The flood was still in progress at the end of February and estimates on the losses below Shreveport are not available at this time.

The Ouachita River reached a stage of 41.1 feet at Camden, Ark., on February 22, or 15.1 feet above flood stage, and 0.4 foot higher than the crest of January 27. Revised estimates of losses in the Ouachita Basin during the last week of January indicate a total of \$75,000. Figures for the February flood have not been received.

West Gulf drainage.—A moderately heavy flood occurred during February in the Trinity River in Texas, following the January flood. This flood began about February 17, and like the January flood, was most severe in the upper portion. At most points the second flood exceeded the first and resulted in estimated losses of about \$60,000 in the upper portion of the Trinity River basin.

Pacific slope drainage.—Following the record December flood in the upper Sacramento Basin, there was a period of more than a month of deficient precipitation, during which time the streams receded slowly to normal winter levels. However, near the end of January a period of heavy rain began which continued throughout the first two weeks of February, over most of the Sacramento and San Joaquin Basins and resulted in a second major flood of the season.

The main flood damage was confined to the Sacramento-San Joaquin delta region, with an estimated total loss for the entire basin of approximately \$1,680,000.

Table of flood stages during February 1938
[All dates in February unless otherwise specified]

Table of flood stages during February 1938—Continued
[All dates in February unless otherwise specified]

River and station	Flood stage	Above flood stages—dates		Crest	
		From—	To—	Stage	Date
ST. LAWRENCE DRAINAGE					
Lake Michigan					
Red Cedar:	Feet			Feet	
Williamston, Mich.....	6	13	16	9.3	13
East Lansing, Mich.....	8	13	16	10.5	14
Grand:					
Lansing, Mich.....	11	14	14	11.6	14
Ionia, Mich.....	21	14	15	21.5	14
Lowell, Mich.....	15	15	16	15.9	15
Cass: Vassar, Mich.....	13	6	9	16.8	7
Lake Huron					
Flint:					
Columbiaville, Mich.....	8	6	22	10.5	8
Flint, Mich.....	11	13	14	11.2	13
Shlawassee: Owosso, Mich.....	6	13	19	7.1	14
Pine: Alma, Mich.....	6	5	11	10.6	6
		12	17	8.3	13
Chippewa: Mount Pleasant, Mich.....	12	6	9	13.2	6
		14	14	12.6	14
Tittabawassee: Midland, Mich.....	18	7	8	19.5	7
		14	14	19.1	14
Lake Erie					
St. Marys: Decatur, Ind.....	13	19	22	14.2	20
ATLANTIC SLOPE DRAINAGE					
Connecticut: Bethel, Vt.....	8	7	7	8.0	7
Mohawk: Schenectady, N. Y.....	15	9	9	16.4	9
Tioughnioga: Whitney Point, N. Y.....	12	7	8	13.6	7
Chenango: Sherburne, N. Y.....	8	6	8	9.0	7
Susquehanna: Oneonta, N. Y.....	12	7	10	13.2	7
EAST GULF OF MEXICO DRAINAGE					
Pearl:					
Jackson, Miss.....	18	22	(1)	20.8	26
Pearl River, La.....	12	25	(1)	13.5	28
MISSISSIPPI SYSTEM					
Upper Mississippi Basin					
Rock: Moline, Ill.....	10	Jan. 25	26	13.8	Jan. 30
Skunk: Augusta, Iowa.....	15	8	9	13.6	10
Illinois:				18.0	9
Peru, Ill.....	17	7	7	17.1	7
Havana, Ill.....	14	Jan. 30	(1)	15.0	1
Beardstown, Ill.....	14	28	(1)	14.0	28—
Bourbeuse: Union, Mo.....	12	19	21	14.0	20
Meramec:					
Sullivan, Mo.....	11	18	20	18.7	19
Pacific, Mo.....	11	18	22	19.3	21
Valley Park, Mo.....	14	18	22	24.0	21
Missouri Basin					
Gasconade: Jerome, Mo.....	15	18	21	17.3	19
Ohio Basin					
Allegheny: Lock No. 8, Mosgrove, Pa.....	24	7	7	25.5	7
Scioto: La Rue, Ohio.....	11	19	20	11.9	20
West Fork of White:					
Anderson, Ind.....	8	11	(1)	10.2	20
Elliston, Ind.....	18	20	25	22.1	22
Edwardsport, Ind.....	12	19	(1)	18.0	24
White:					
Petersburg, Ind.....	16	22	(1)	18.7	26, 27
Hazleton, Ind.....	16	22	(1)	19.1	27, 28
Wabash:					
Lafayette, Ind.....	11	19	23	15.9	21
Covington, Ind.....	16	20	24	19.1	22
Terre Haute, Ind.....	14	20	27	15.7	25
White Basin					
Current: Doniphan, Mo.....	10	18	21	18.0	19
Black:					
Leeper, Mo.....	11	18	19	16.0	18
Poplar Bluff, Mo.....	14	18	22	17.4	20
Black Rock, Ark.....	14	16	Mar. 10	25.1	19
White:					
Cotter, Ark.....	21	17	21	31.0	19
Calico Rock, Ark.....	18	16	22	42.0	18—19
Batesville, Ark.....	23	16	23	39.5	19
MISSISSIPPI SYSTEM—continued					
White Basin—Continued					
White—Continued.					
Newport, Ark.....	26	Jan. 18	27	33.4	20
Georgetown, Ark.....	21	Jan. 30	7	22.3	2
		18	Mar. 12	31.5	23
Clarendon, Ark.....	26	Jan. 29	13	27.7	7
St. Charles, Ark.....	24	Jan. 19	Mar. 23	35.0	28
		29	(1)	31.8	Mar. 5
Arkansas Basin					
Poteau: Poteau, Okla.....	21	Jan. 16	23	36.0	19
Petit Jean: Danville, Ark.....	20	Jan. 31	2	21.5	1
		17	23	29.3	18
Arkansas:					
Webbers Falls, Okla.....	23	17	20	26.8	18
Fort Smith, Ark.....	22	16	22	33.2	19
Van Buren, Ark.....	22	16	23	32.4	19—20
Ozark, Ark.....	22	17	22	28.9	20
Dardanelle, Ark.....	22	17	23	29.6	19
Morrilton, Ark.....	20	18	24	27.8	21
Little Rock, Ark.....	23	19	24	26.2	22
Pine Bluff, Ark.....	25	19	25	31.7	23
Red Basin					
Little Missouri: Boughton, Ark.....	20	18	20	23.6	19
Ouachita:					
Arkadelphia, Ark.....	17	18	21	29.0	19
Camden, Ark.....	26	Jan. 20	Mar. 1	41.1	22
Little: Whitecliffs, Ark.....	25	Jan. 24	1	31.0	Jan. 26
		19	28	30.7	20
Sulphur:					
Ringo Crossing, Tex.....	20	Jan. 18	24	30.5	19
Naples, Tex.....	22	Jan. 23	4	35.0	Jan. 25
Cypress: Jefferson, Tex.....	18	Jan. 20	(1)	30.4	21—22
Red:					
Arthur City, Tex.....	27	18	22	34.7	19
Index, Ark.....	25	19	27	34.4	23
Fulton, Ark.....	25	Jan. 24	2	32.9	Jan. 28
Springbank, Ark.....	37	Jan. 19	(1)	36.4	24
Grand Ecore, La.....	33	Jan. 27	(1)	38.1	27
		31	8	35.7	4
Alexandria, La.....	32	Jan. 24	(1)	36.9	7
		22	(1)		
Lower Mississippi Basin					
Big Lake Outlet: Manila, Ark.....	10	Jan. 26	(1)	17.5	24—25
St. Francis:					
Fisk, Mo.....	20	Jan. 18	25	24.9	21
St. Francis, Ark.....	18	Jan. 29	9	19.9	1
Tallahatchie: Swan Lake, Miss.....	26	Jan. 18	(1)	23.4	24
		28	(1)	30.3	6
WEST GULF OF MEXICO DRAINAGE					
Sabine: Logansport, La.....	25	4	16	31.3	7
Elm Fork: Carrollton, Tex.....	6	17	21	12.6	18
Trinity:					
Dallas, Tex.....	28	Jan. 17	24	41.3	19
Trinidad, Tex.....	28	Jan. 23	5	39.8	Jan. 29
		19	(1)	44.8	24
Long Lake, Tex.....	40	Jan. 27	8	45.0	Jan. 29
Liberty, Tex.....	24	24	(1)	45.3	27
Brazos: Waco, Tex.....	27	3	17	26.1	12
		18	18	28.1	18
PACIFIC SLOPE DRAINAGE					
San Joaquin Basin					
Mokelumne: Bensons Ferry, Calif.....	12	12	15	15.4	12
San Joaquin: Lathrop, Calif.....	17	14	19	18.7	15
Sacramento Basin					
Sacramento:					
Red Bluff, Calif.....	23	8	10	24.8	8
Knights Landing, Calif.....	30	14	14	23.1	14
		9	18	32.0	12
Columbia Basin					
Coast Fork: Saginaw, Oreg.....	9	6	7	10.6	6
Willamette: Harrisburg, Oreg.....	10	7	8	10.6	7

¹ Continued at end of month.